

ENGINEERING ROAD SAFETY FOR AN AGEING PEOPLE

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ABSTRACT

This paper will provide an overview of road safety in Singapore and relates it to international practices. It outlines the key road safety strategy and highlights important initiatives taken to enhance road safety for road users particularly for elderly people.

It is a challenge for transport authorities to balance traffic efficiency and make roads safer for all, particularly the elderly people. Besides international best practices like Black Spot Program and Road Safety Audits that pick up vulnerabilities for improvements, the paper also showcases various measures to improve road safety for the elderly.

1. INTRODUCTION

Increasing needs of the elderly

Singapore's population is ageing. With it, the society needs have been changing over the past few years, as is evident from requests made through various feedback channels. For example, on 15 February 2009, this was carried in a local newspaper: "Bridge ramps for seniors, please. I would like to know if ramps will be built for the pedestrian bridges just outside (my home). Sometimes, I wonder if planners know what it is like to grow old or be short of breath climbing these bridges. Please have a heart."

On 20 May 2009, another wrote “Extend traffic crossing duration. When I cross a road quickly, I often have only 4 seconds to spare. It must be a struggle for the elderly to make it across the road in good time. Extending the duration of the green-man light would make crossing the road a less stressful experience.”

Road safety needs of the seniors or elderly are increasingly becoming a concern. It is noted that in 2008 elderly pedestrians (people of 60 years and older) account for almost half of pedestrian deaths [1]. Singapore’s population is indeed ageing rapidly because of longer life expectancy and a low birth rate. Over the next 20 years, Singapore will experience an unprecedented age shift. This will have a huge impact on all aspects of life, including road safety.

Ageing and road safety

Hence, it is timely to share Singapore’s experience on how we are engineering road safety for an ageing people. Well, “The ageing are not only the old; the ageing are all of us.” I quote Alexandra Robin gerontologist and writer of “Ageing: A New Look”. Likewise, I would say engineering road safety is not only for the old but for all road users as well.

The OECD report on Ageing and Transportation [2] also called for a shift in major policy priorities including the development of safer roads for older people. Research shows that the elderly have a higher than average death rate in traffic [3]. The most important cause of this high death rate is their greater physical vulnerability. As people age, function limitations and disorders happen. These include reduced visual acuity and perception reaction time which can increase the crash rate of road users. Infrastructural measures can reduce the crash involvement of the elderly such as a well-maintained contrast level of road markings, and ensuring motorists get information in good time about the traffic situation they are approaching. This is especially important for the elderly because they generally need more time to select the right information and use it to take the correct action.

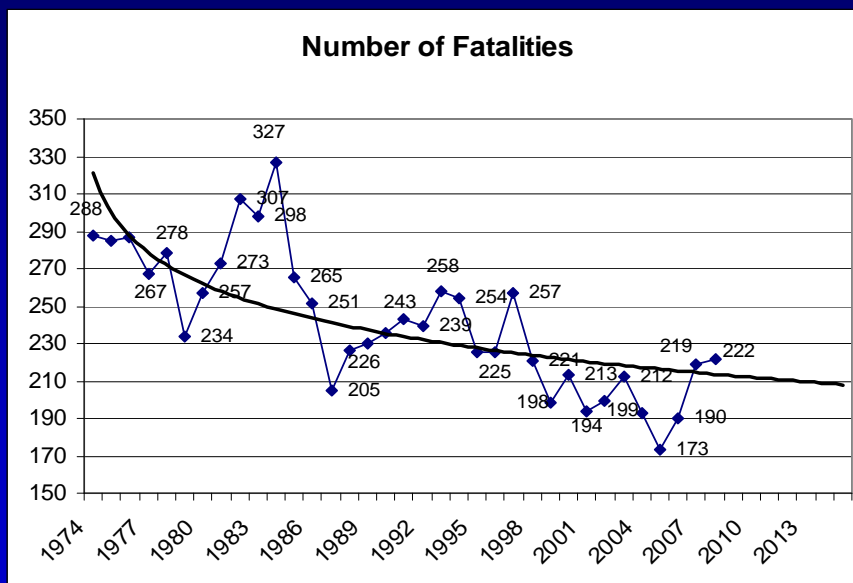
2. OVERVIEW OF ROAD SAFETY IN SINGAPORE

Singapore is a small city-state with a dense population of over 4.5 million. Roads take up 12% of our total land area. Road infrastructure is well developed and well maintained with lighting on every public road. Usage demand management and other controls have resulted in a low level of car ownership compared to many developed countries. About 20% of all motor vehicles are motorcycles. The road network is highly urbanised and vehicle fleet modern.

Nevertheless, Singapore has a relatively good road safety record. Even with increasing human and vehicle population, the number of road fatalities has been decreasing over the years (Figure 1). In 2008 [1], there were 213 fatal and 8,238 injury accidents that resulted in 222 fatal and 10,742 injured casualties. Out of the 222 fatalities in 2008, 49% involved motorcyclists/pillion riders and 28% involved pedestrians. These are the two most vulnerable groups of road users. A major proportion of the fatal accidents are speed-related accidents.

Hence, more aggressive measures specifically targeted at these 3 problem areas are being introduced. The groups of road users that are more susceptible to fatal accidents are young motorcyclists (20-24) and elderly pedestrians (above 60). This is of concern as we have an ageing people. Elderly pedestrians account for almost half (45% or 28) of the 62 pedestrian deaths. Of the 28 fatalities involving elderly pedestrians, 22 of them were killed as a result of jaywalking.

Road Safety Situation in Singapore



Land Transport Authority

Figure 1. Road fatalities trend in Singapore (Source: <http://www.spf.gov.sg/stats>)

Singapore's road safety records have been improving over the years. Over the past 10 years, our road fatality rate has progressively reduced to 4.6 in 2008 from 5.0 fatalities per 100,000 population in 1999. As a tribute to our various efforts in making the road safe, the Land Transport Authority (LTA) together with the Traffic Police (TP) have won the Prince Michael International Road Safety Award in December 2007. While Singapore's roads are recognised to be among the safest in the region, there is still room for improvement when compared with the world's best standard (Figure 2).

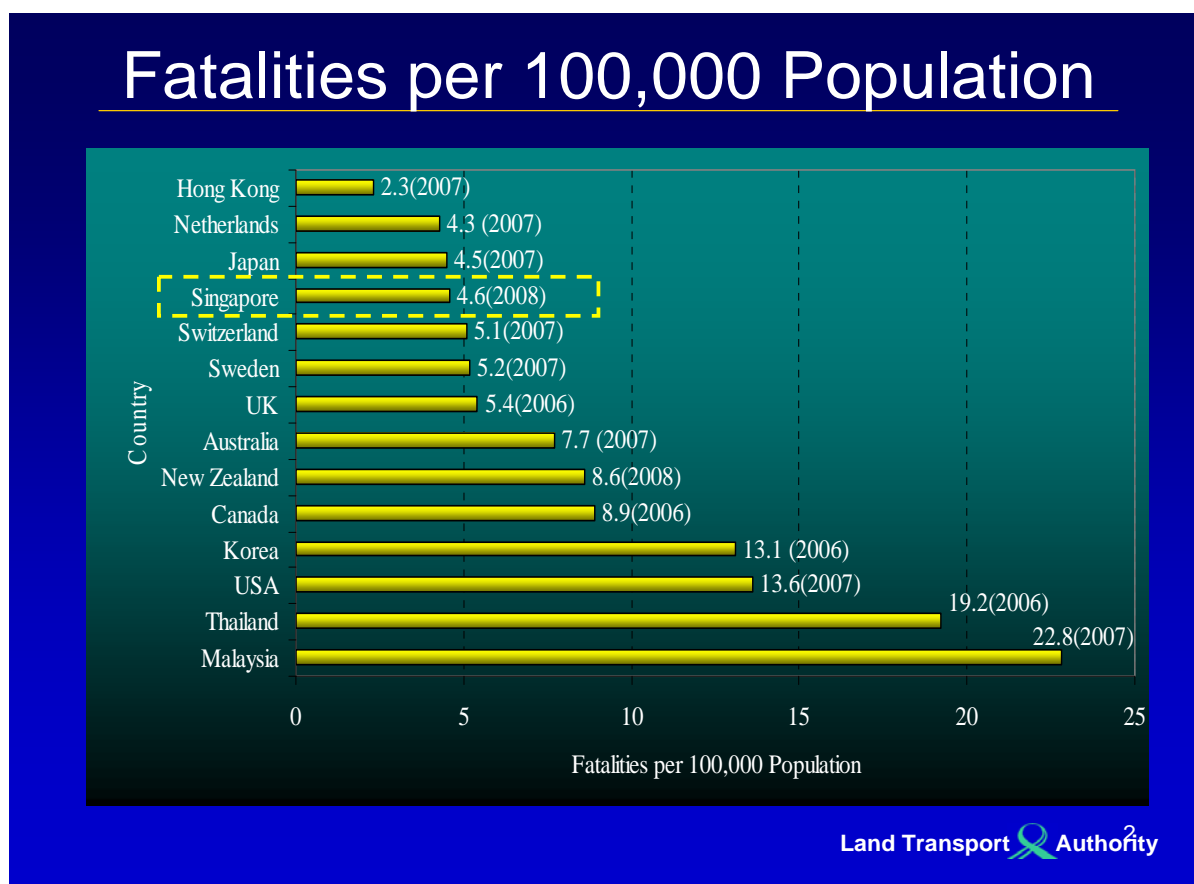


Figure 2. International comparison of road fatalities per 100,000 population

Source: (from websites of each country)

3. ROAD SAFETY STRATEGY

In Singapore, the Land Transport Authority (LTA) and Traffic Police (TP) are the two government agencies responsible for managing road safety. LTA provides a safe physical road network for road users, while TP enforces traffic regulations with public education. In addition to the efforts made by the government, LTA and TP partner with other non-government organizations such as the National Safety Council (NSC) to enhance and promote road safety.

This partnership is historical and has worked very well for many years. One outcome of this successful partnership among LTA, TP and NSC is the Global Road Safety Week (an UNESCAP road safety initiative) and Road Safety Conference held in April 2007. Moreover, we also collaborate with the private sectors, institutions and road users to achieve major improvement in road safety.

Road accidents result in loss in lives and injuries, and lead to congestion and delays for road users. Thus it is important for LTA to continue in its efforts to enhance road safety, especially for the vulnerable groups including the elderly.

Road safety professionals can engineer to prevent and reduce road accidents. However, there is also a need to champion greater road safety awareness among all road users. With more vehicular traffic and a growing population each year, we have implemented various road safety measures to ensure road fatalities in Singapore are kept low.

Road safety approach

Our vision is to work towards a people-centred land transport system. We aim to provide a safe and excellent travel experience for all road users including the elderly. Our mission is to give service excellence in providing a safe, cost effective and optimal road transport infrastructure. While safety is of paramount importance, we need to have a balance between road safety and traffic efficiency. In 1998, LTA set up a dedicated Road Safety Engineering Unit to implement the world's best practices for road safety management and deliver safe roads to the public, through the planning, implementing and managing of various road safety initiatives.

LTA's role in enhancing road safety focus on three road safety approaches. The first is the reactive approach to treat locations where accidents have occurred while the second is a proactive approach to treat locations before they become black spots. The third approach focuses on support, research and collaboration with major national stakeholders like TP and NSC; regional stakeholders from ASEAN and APEC countries; international stakeholders such as WHO and Global Road Safety Partnership (GRSP).

In short, there are 7 core areas under these 3 approaches as illustrated in Figure 3.



Figure 3. Singapore's road safety strategy

4. PROACTIVE MEASURES

Road Safety Audit (RSA):

Since 1999, LTA use RSA as a road safety engineering tool to examine Singapore's roads and assess their accident potential and safety performance. Both day and night audits are conducted in line with best practices like AusRoads. Road safety engineers identify potential road hazards of existing and future roads and rectify these hazards before accidents happen. Thus RSA is a proactive measure.

Significant progress is made over the years to make our roads safer, with RSA conducted for many main roads including all expressways. New roads are reviewed at various stages for safety concerns. RSA reveals, for example, the safety concerns at the gore area for vehicles exiting from the main expressway to slip roads. Follow-up improvements include treating these gore areas with *hazard markers* and installing *crash cushions* to lessen the severity of accidents involving errant drivers at these locations, and save lives. Research shows that these cushions absorb the impact of the crash and reduce the probability of injury to motorists.

RSA also recommends cost-effective measures such as standardization of *end treatment* of vehicle impact guardrails (ramp down), *high entry angle treatment* for slip roads, and *shifting stop line* outwards to improve motorist's sight distance of side roads. Other measures include *covering of drains* where necessary to minimize the risk of being injured or killed if one drove or fell into the drain.

Hazardous Road Locations (HRL):

HRL work is a complement to RSA as engineers look out for potential hazards on the roads. Potential dangerous spots were identified from public feedbacks and information on frequently hit locations. Alternatively, HRL were picked up through observations by our site officers on the roads. These could be rectified promptly using simple, cost-effective treatments such as erecting railings to deter jaywalking, curve alignment markers at sharp road bends, the use of road markings and road-signs to prohibit unsafe driving such as overtaking, parking and speeding.

Road Safety Project (RSP):

Under this core area, engineers carry out various new road safety initiatives and trials with technologies adapted from overseas to suit local community use. International best practices and lessons are explored and evaluated for island wide application here. This is then followed by implementation of specific road engineering solutions to minimize the risk of accidents at the targeted spots.

Safety initiatives for motorists

Real-time speeds of speeding motorists are displayed on an electronic "*Your Speed*" Sign (YSS) at specified stretches of some roads. That means motorists have exceeded the speed limit along the stretch of road. Our research shows that this vehicle-activated speed display sign raises motorist's awareness and encourages motorists to reduce vehicle speeds and obey the speed limit. Presently, YSS are used at black spot sites with speed-related accidents.

Some traffic lanes seem to be narrowing due to the visual effect of two rows of white triangles, to slow down motorists. This is because of the *Traffic Calming Marking (TrCM)*, a psychological traffic calming measure for motorists. Our studies show that TrCM is effective to help motorists observe and moderate their speeds. TrCM is introduced on roads where speeding is a concern, especially in residential areas, where other measures like road humps and speed regulating strips have the disadvantage of noise to adjacent residents. TrCM is a softer approach to calm traffic using innovative road markings to narrow the road.

On the roads, various forgiving devices are also used, like *spring-loaded posts* with better reflectivity at centre dividers, replacing the conventional delineator posts. In addition, *flexible posts* with yellow and black stripes are implemented on road pavement to help improve conspicuity of the gore areas with crash cushions.

On approaches to a concealed signalised junction (usually at bend or after a crest), motorists will see the flashing *Advanced Warning Light (AWL)* to alert them to slow down for the red traffic lights ahead. AWL warns motorists in advance to a red traffic signal and that they need to prepare to stop. It is a useful active device to advise motorists of the change in signal phasing at the downstream obscured traffic signals. AWL incorporates twin flashing amber aspects mounted on a pole. Positioned in between this pair of aspects is a "Prepare to Stop" information sign. On top of the amber aspects is a "Traffic Light Ahead" sign.

At sharp bends on the roads are *curve alignment markers*, which are made of highly reflective yellow/black material to guide motorists in negotiating them safely. *Vibraline markings* that are installed along expressways are used to alert fatigued drivers who may have swayed from their traffic lane.

Safety initiatives for motorcyclists

About 50% of road fatalities in Singapore involve motorcyclists or their pillion riders. While education and enforcement will continue to be undertaken to enhance road safety, engineering measures will also be intensified. Road surfaces at accident-prone locations will be treated with *high skid-resistance material* to give better control for all road users, particularly motorists.

Red-Amber-Green Arrow (RAG) or protected right turns are used to regulate the right turning movements at some problematic traffic light junctions. Due to the inconspicuousness of the motorcyclists on the road, this measure helps to reduce the chances of motorcyclists involved in accidents due to misjudgement from either right-turning or on-coming vehicles.

Road bends are delineated with curve alignment markers to help motorists, especially motorcyclists to manoeuvre the bends better.

Safety initiatives for public transport road users

Bus safety bollards at bus stops are used to protect bus commuters from direct impact of errant vehicles along high speed roads. *Yellow band* is painted near the edge of every bus stop to guide bus commuters to stay away from the bus bay.

Safety initiatives for pedestrians

Generally speaking, walking on Singapore's roads is increasingly becoming more convenient as we provide pedestrians with barrier-free accessibility by ramping down parts of many of the sidewalks and kerbs. This also helps the elderly to get off the roads and onto the footpaths with ease and in a safer manner. If traffic conditions permit, elderly-friendly features such as at-grade or road-level crossings are provided in areas where the elderly frequent.

"*Watch out for Elderly Pedestrians*" signs are used to remind all road-users to watch out for elderly crossing the road. These signs can be installed near overhead bridges so that motorists nearing an overhead bridge are more alert and be prepared to brake for jaywalking elderly pedestrians. Majority of elderly fatalities are due to jaywalking, usually along two-way roads. Railings can be installed along centre medians to deter pedestrians from jaywalking by putting up railings.

At zebra crossings

As motorists approach a zebra crossing, a pair of white triangular road markings may be used to forewarn motorists that there is a zebra crossing ahead and to prepare them to give way to pedestrians. These *Pedestrian Crossing Ahead Markings (PCAM)* provide additional warnings to motorists to give way to pedestrians on approaching zebra crossings where there are sight distance deficiencies such as the view of crossing pedestrians is partially blocked by structures and big trees. It can be a cost-effective alternative to converting them to either raised zebra crossing or signalised pedestrian crossing with advanced warning lights to enhance pedestrian safety.

Blue pedestrian crossing signs attached to the flashing beacon posts are used to further enhance the conspicuity of zebra crossings. Flashing beacon posts are now placed lower for better visibility. We have replaced all flashing beacons with *LEDs* instead of halogen bulbs for better brightness and reduced needs for maintenance, thereby ensuring that these warning lights go not get blacked-out. And where lighting at the pedestrian crossings is insufficient, we provide *floodlights*.

At traffic light crossings

Dashed pedestrian crossing lines (DPCL) are increasingly used to replace the continuous lines and make them easier for drivers to distinguish the “stop” line from the pedestrian crossing. This reduces the probability of them not stopping in time before the crossing so as not to collide into pedestrians who are crossing. Our pilot project in the city and residential area shows positive results of motorists’ compliance at the stop line after introducing DPCL. DPCL helps increase the road safety of elderly pedestrians who are slow in crossing the roads, as they also tend to have slower reflexes and agility, therefore are unable to get out of the way if a car is speeding towards them. DPCL is gradually implemented at all signalised junctions and mid-block pedestrian crossings to contrast and differentiate from the stop line.

Blinking *Intelligent Road Studs (IRS)*, a form of wired blinking LED road studs (flushed to the ground) are used to warn turning motorists to watch out and give way to pedestrians crossing alongside. The IRS is pedestrian-activated via the pedestrian demand push button linked to the traffic light signals. The IRS starts blinking when the green man is activated upon pedestrian demand. It serves as additional warning device for motorists to pay attention and give way to pedestrians using the crosswalks. IRS provides more warning to motorists, with its flashing amber lights, making crossing pedestrians more visible and conspicuous especially in the dark.

Elderly pedestrians would benefit from the installation of IRS. Due to their slower walking speeds and reduced agility, the elderly pedestrians may not be able to avoid the path of oncoming vehicles. Therefore, it would be advantageous to them by pre-warning motorists instead.

These mentioned schemes help to make the presence of pedestrian crossings more conspicuous and lower the chances of pedestrians from being hit by negligent or errant motorists.

Pedestrian audio signal at some traffic lights provides an audio signal function that emits different audio signals to help the visually handicapped cross the road. This audio signal is useful for elderly pedestrians where they have failing eyesight and are unable to see the green man from afar. The beeping sound will let them know when they can cross the road and when not to. The beeping sound is more of an aid to them when they use the pedestrian crossings.

At many places, *green-man countdown timers* indicate the amount of time left in the pedestrian crossing phase. They are usually installed at signalized pedestrian crossings near schools and busy junctions. Pedestrians should not start to cross the road when the green man is flashing, as they may not be able to complete the crossing. The timer is effective as an informant and reminder to elderly pedestrians how much time they are left to cross the road

Elderly pedestrians are at greater risk to road fatalities because of their slower walking speeds. A longer duration is used for the green light at pedestrian crossings in estates with a higher proportion of elderly persons staying. *Radio Frequency Identification (RFID)* technology is being tested to detect elderly pedestrians crossing the road. When the RFID readers, which are mounted on the traffic light poles, detect the RFID cards held by elderly pedestrians who wish to cross the roads, the system will extend the 'green man' timing, giving them more time to make their way across the roads. This elderly-friendly traffic system will greatly benefit Singapore's increasing ageing population.

At pedestrian overhead and underpass crossings

Overhead bridges are built with *ramps* (where there is no site constraint) to help especially elderly pedestrians to cross roads in safety. The ramps are intended to ease the strain placed on the knees and legs of elderly pedestrians. Ramped overhead bridges and underpasses can encourage more pedestrians, especially elderly ones, to use them and not jaywalk, hence ensuring their safety when crossing roads.

Safety initiatives for school children

Road safety improvement near schools include the *enhanced school zones* at primary schools to increase the visibility of school zones, and raise motorist awareness of small children crossing in the area. The scheme comprises two simple easy-to-read signs demarcating the boundary of the school zone as well as red-pigmented stretches of pavement along the approach roads in the school vicinity. We also engage the schools to train parents as traffic wardens to guide young children crossing the roads. This scheme has received favourable public feedback.

5. REACTIVE MEASURES

Black Spot Program (BSP):

The BSP is an important road safety engineering strategy used, to systematically identify and treat accident-prone locations based on predefined criteria and target. In Singapore, the BSP was set up through many years of planning and hard work to get the accident database reliable and ready for use. A high quality GIS map-based Traffic Accident Analysis Module (TAAM) was developed in 2005 to allow road safety engineers to identify black spot locations, analyse the accident trends, and understand the contributory factors leading to accidents at specific locations. This allows the use of appropriate engineering solutions to treat the accident locations effectively and prevent future accidents from taking place.

The BSP aims to reduce the accident numbers if not the severity of the accidents through various black spot treatments. In a dense urban road network, many of the sites targeted are signalised junctions. For example, the BSP reveals a high percentage of junction accidents involve right turning vehicles. Treatments such as Red-Amber -Green (RAG) arrows have been installed to control right turns and the results have been considered positive. For example at the junction of Upper Serangoon Road/Upper Paya Lebar Road/Boundary Road, after RAG implementation, the number of accidents dropped by 80% from 15 to 3 over 12 months.

BSP also reveals that many accidents involving motorcyclists losing control on expressways when the road surface was wet. As a result, some sections of the expressway network have been resurfaced with better quality and higher skid-resistant material. This has resulted in a substantial reduction in the number of such accidents.

Through this program, cost-effective treatments were implemented with the aim to reduce the number if not the severity of the accidents that occurred at the black spots. Sometimes, the countermeasures need not be purely engineering; it might include installing Red Light Cameras and targeted publicity and education for a particular group of road users.

Accident Investigation & Prevention (AIP)

The AIP work focuses on the investigation of fatal accidents. This is the initial step into reactive measures taken in the early years of road safety engineering work in Singapore. Given limited manpower and resources, fatal accidents which are comparatively more costly than others are treated with higher priorities. The common schemes implemented include improving lighting level, and installing pedestrian barriers like railings.

6. SUPPORT, COLLABORATION AND RESEARCH

With strong support, close collaboration and research in road safety, we are able to have opportunity to share and exchange road safety knowledge and experience with other national strategic partners such as TP and NSC; and international road safety organizations like GRSP, UNESCAP and WHO. Our regional road safety partners include our counterparts and road safety experts from ASEAN and APEC countries.

International and national road safety initiatives

LTA supports the NSC in hosting the Global Road Safety Partnership GRSP (Asia) Road Safety Seminar which will be held in Singapore in October 2009. Besides NSC, we also work closely with other NGOs like Singapore Action Group for the Elders (SAGE) to promote safety for our ageing people.

We also initiate the co-ordination with TP to collate Singapore road safety data and statistics as part of the World Health Organization (WHO) Global Status Report on Road Safety. This report serves to advocate increased focus and investment on road safety internationally. LTA participates as an Observer in the ISO-led initiative by Sweden to develop an international standard for road safety management. We are exploring the conduct of an iRAP or International Road Assessment Programme to benchmark our roads with different level of risks and star rating.

Road Safety Consultation (RSC):

LTA provides consultancy in areas of road safety engineering. We conduct training courses to share our experiences in road safety engineering and management with many countries including Laos, Myanmar, Cambodia, Vietnam, Bangladesh, Sri Lanka and Brunei.

Road Safety Action Plan (RSAP):

The World Health Organisation (WHO)'s Report on Road Traffic Injury and Prevention in 2004 recommends that "each country should prepare a national road safety strategy and plan of action." Then the first Road Safety Action Plan (RSAP) was officially launched at the National Road Safety Exhibition and Rally in 2005. The RSAP is the result of a strategic collaboration between various government agencies, non-governmental organisations and the private sector, with the aim to set common targets on road safety strategies. It is specifically tailored to the particular needs of Singapore. The RSAP leads to greater emphasis and commitment on road safety issues and spurs more road safety initiatives.

The national Road Safety Action Plan is a timely effort by the various government agencies to come up with concrete initiatives to improve road safety. In particular, there is a need for a concerted effort by both road users and the relevant government agencies to reduce the number of accidents.

Besides engineering measures for road safety, the Action Plan also focuses on other non-engineering aspects, predominantly education and enforcement. Emergency Preparedness is another aspect mentioned in the Plan as an important element since lives can be saved with adequate and correct emergency response in handling accident victims.

7 CONCLUSION

This paper has highlighted several road safety engineering measures used in Singapore to make the roads safer for all users including the elderly people. It is a challenge for transport authorities like the LTA to balance traffic efficiency and make roads safer.

In conclusion, while it is a fact that the population is ageing, it is important that road safety professionals and policy makers continue to work closer together to improve the accessibility of Singapore's transport system to enable the elderly remain safely connected to the community.

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